DEVICE FOR REMOVING HEAT FROM ELECTRICAL EQUIPMENT

BACKGROUND

Electrical equipment may include multiple printed circuit boards that are located within the same chassis. In one example, the electrical equipment is network processing equipment, such as a router, switch, concentrator, gateway, etc. The network processing equipment may include multiple line cards that provide interfaces for establishing multiple network connections. The line cards establish individual connections to computers, servers, Voice Over Internet Protocol (VoIP) phones, etc. The network processing equipment route or switch data on the connections over a Wide Area Network (WAN) or Local Area Network (LAN).

The line cards are powered using power connectors. The power supplied by the power connectors generate heat on the line cards and in the chassis containing the line cards. Too much heat can damage the electrical traces and electrical components on the line cards. Thus, the amount of power that can be supplied to the line cards in the network processing equipment is limited by the amount of heat generated.

More power is required to increase processing capacity in network processing equipment. For example, some network processing equipment applications can require more than 200 amps of power. This is equivalent to the current rating on an electrical panel in a residential home. However, printed circuit boards in existing network processing equipment cannot withstand the heat generated by this much power. These heat restrictions severely limit the processing capacity of network processing equipment.

The present invention addresses this and other problems associated with the prior art.

SUMMARY OF THE INVENTION

A heat removal device includes a shroud on a top side of a printed circuit board that contains a power connector. An air intake vent is located underneath the printed circuit board and directs air up through printed circuit board vias into the shroud. Openings are located in a power connector housings that allow air to flow over conductors in the connector and out an air outtake vent. The conductors include heat sink fins that extend out of the openings in the connector housing.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a cutaway view of network processing equipment.

FIG. 2 is an enlarged view of heat removal devices located in the network processing equipment.

FIG. 3 is an isolated view of one of the heat removal devices with an upper shroud shown with see-through lines.

FIG. 4 is front cutaway view of the heat removal device.

FIG. 5 is an isolated view of conductor plates located inside a power connector.

DETAILED DESCRIPTION

FIG. 1 shows network processing equipment 12 that establishes connections 16 with multiple computers 14 or phones 18. The connections 16 can be established over a land line or wireless medium and are carried over a circuit switched network or a packet switched network. The phone 18 can be a Plain Old Telephone Service (POTS) phone or a Voice Over Internet Protocol (VoIP) phone.

The network processing equipment 12 routes or switches data on connections 16 over a Wide Area Network (WAN) or Local Area Network (LAN) packet switched network

referred to generally as Internet network 30. In one embodiment the network processing equipment 12 is a router, switch, call concentrator, gateway, or any other type of network processing circuitry that processes packet data. However, it should be understood, that this is just a preferred embodiment and the heat removal system described below can be used for any type of electrical equipment.

The network processing equipment 12 includes multiple line cards 20 that each process data for connections 16. The line cards 20 are contained within a chassis 13 and each receive power from a power supply 24. The power supply 24 includes a plug 32 for plugging into a wall power outlet (not shown). The power supply 24 converts Alternating Current (A.C.) power from the wall power outlet to a lower voltage used for operating electrical components on the line cards 20.

A power cable 26 runs from the power supply 24 to individual heat removal devices 22. The heat removal devices 22 each include a power connector 40 (FIG. 2) that physically connects power from the power supply 24 to power planes on the printed circuit boards 20. The heat removal devices 22 are located next to a fan 28 that sucks air out of the chassis 13 creating air flow 34.

Referring to FIG. 2, the heat removal devices 22 include power connectors 40 that are plugged into contact holes (vias) in the printed circuit boards 20. In one embodiment, the power connector 40 is incorporated into an industry standard bladed Future Bus connector. However, the invention can also be incorporated into other types of power connectors.

The Future Bus connector is modified by exposing internal conductors and fanning out the conductor blades to extend outside a plastic connector housing. An air flow control device 42 includes an upper shroud 44 that sits on a top side of the circuit board 20 and contains the power connector 40. The air flow control device 42 also includes an air intake

vent 46 that attaches to a bottom side of the circuit board 20 and is connected to the upper shroud 44 by a hinge 48. The air flow control device 42 can be made from plastic or any other material.

The fan 28 is located in the chassis 13 adjacent to the heat removal devices 22. In one embodiment there are multiple fans 28 stacked on top of each other on one side of the chassis 13. Exhaust vents 50 are located on the right side of each shroud 44. The fan 28 sucks air out from the exhaust vents 50. In an alternative embodiment, instead of pulling air from the exhaust air vents 50, the fan 28 is located on the opposite left side of the chassis 13 and blows air into the intake air vent 46.

As described in further detail below, the configuration of the air flow control device 42 in relation to the fan 28 creates a low pressure area on the top sides of the circuit boards 20. This low pressure causes air flow 34 from the bottom sides of the circuit boards 20 to travel up through vias 52 (see FIGS. 3 and 4) in the printed circuit boards 20. The upwardly traveling air flow 34 is then sucked by the fan 28 through the power connectors 40 and out the exhaust vent 50.

FIG. 3 shows one of the heat removal devices 22 with the shroud 44 and the printed circuit board 20 drawn with see through lines. The connector 40 includes multiple conductor blades 60 that electrically connect the power cable 26 (FIG. 1) to power planes 54 that extend along the circuit board 20. Front connecting face 59 of the connector 40 electrically receives a plug from power cable 26. The conductors 60 are contained within a plastic housing 62.

Of particular interest are openings 64 that exist on opposite sides of the housing 62. In one embodiment, at least one side of the housing 62, other than the front connecting face 59, includes an opening 64 for promoting air flow across the conductors 60. A large amount of heat can be generated by the conductors 60. The openings 64 in combination with the

directed air flow provided by the air flow control device 42 increases the amount of heat transferred away from the conductors 60. In one embodiment, the conductors 60 include fins 61 that fan out from opposite sides of the conductors 60 and extend out of the housing opening 64. The conductor fins 61 operate as heat sinks thermally removing heat from the conductors 60.

The air intake vent 46 is held underneath the printed circuit board 20 by the hinge 48 and a screw 58. The screw 58 inserts though a hole in an extension piece 66 of the shroud 44 and a hole in the circuit board 20. The screw 58 is received by a corresponding extension piece 66 in the air intake vent 46. The air intake vent 46 includes a cowling 56 that directs air from underneath the printed circuit board 20 up through circuit board vias 52 and into the opening 64 in the connector housing 62. This air flow travels over the conductors 60, out the opening in the opposite side of the housing 62 and then out exhaust vent 50.

Another source of heat, in addition to the conductors 60, is the areas of the power planes 54 that make physical contact with the conductors 60. The vias 52 are connected to the power planes 54. The heat removal device 22 causes air to flow up through the vias 52 and remove heat generated at the contact points between the conductors 60 and the power planes 54. In one embodiment, the vias are around 50 millimeters in diameter.

FIG. 4 is a front-sectional view of the heat removal device 22. The conductors 60 are electrically connected to the power plane 54 through contacts 70. These contact 70/power plane 54 physical contact areas are high heat generating areas. Air flow 34 travels from underneath the printed circuit board 20 into the air intake vent 46 and up through the vias 52. The air flow 34 travels up through the vias 52 and into the left opening 64 in the plastic connector housing 62. The air flow 34 travels over the conductors 60 and conductor fins 61

and out the right opening 64 in the housing 62. The air flow 34 then travels out of exhaust vent 50 and out of the chassis 13 via the fan 28.

FIG. 5 is an isolation view of the conductors 60 located in power connector 40. The conductors 60 include multiple metal plates that plug into vias in the circuit board 20. The conductors 60 extend up from the printed circuit board 20 and then bend forward forming the front connecting face 59 of the connector 40. Fins 61 spread laterally out from opposite sides of the conductors 60 and extend out of the openings 64 on opposite sides of the connector housing 62 (See FIG. 3).

Having described and illustrated the principles of the invention in a preferred embodiment thereof, it should be apparent that the invention may be modified in arrangement and detail without departing from such principles. I claim all modifications and variation coming within the spirit and scope of the following claims.